Description and Evaluation of a New, Pneumatically Operated Ekman-Type Grab

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ABSTRACT

Burton, W., J.F. Flannagan, and D.G. Cobb. 1985. Description and evaluation of a new, pneumatically operated Ekman-type grab. Can. Tech. Rep. Fish. Aquat. Sci. 1332: iv + 8 p.

A new Ekman-type grab, operated using a pole or handle and with jaws which are opened and closed pneumatically is described. The grab was designed for use in the coarser substrate of rivers, streams and the littoral zones of lakes.

In comparative trials with a Ponar grab, the new grab collected significantly more of most macrobenthic animals in both gravel and "sand with twigs" substrates. No significant differences were found between the grabs in a sand substrate in the Roseau River probably because of the large variation in numbers of animals among the individual samples.

The new grab incorporated most of the advantageous design features of Ekman-type grabs.

Key words: grabs; benthos; evaluation; pneumatic; Ekman; ponar.

RESUME

Burton, W., J.F. Flannagan, and D.G. Cobb. 1985. Description and evaluation of a new, pneumatically operated Ekman-type grab. Can. Tech. Rep. Fish. Aquat. Sci. 1332: iv + 8 p.

Le présent rapport décrit une nouvelle benne preneuse du type Ekman, actionnée à l'aide d'une tige ou d'un levier et comprenant des mâchoires à ouverture et fermeture pneumatique. La benne a été conçue pour être utilisée dans le gros substrat des rivières, des ruisseaux et des rives des lacs.

Au cours d'essais de comparaison avec la benne preneuse Ponar, la nouvelle benne a prélevé sensiblement plus d'animaux macrobenthiques dans les substrats de "sable et brindilles" et le gravier. On n'a trouvé aucune différence entre les bennes lorsqu'on les a utilisées dans un substrat sablonneux de la rivière Roseau, probablement à cause des grandes variations des nombres d'animaux prélevés dans chaque échantillon. La nouvelle benne présentait la plupart des avantages des bennes du type Ekman.

Mots-clés: benne preneuse; benthos, appréciation; pneumatique; Ekman; Ponar.

INTRODUCTION

Burton (1978) analysed the mechanical characteristics, depth penetration and bite of a number of grabs. He concluded that, since no one sampler will take satisfactory samples on all substrates, great care should be taken to select a sampler suitable for both the kinds of animals under study, and the substrate to be sampled. Flannagan (1970), in tests of a large number of grabs and corers, found the Ponar and Shipek grabs to be the best available for sampling the benthos of sand and gravel substrates in lakes but concluded that neither was satisfactory.

The grab described here is comparatively light (9 kg); can be handled by one person; has similar hydrodynamic characteristics and bite profile to the FRB Ekman (Burton and Flannagan 1973); allows control over depth penetration, since it is controlled directly using a handle and has sufficient power to close in dense substrates since the jaws are closed pneumatically.

The grab was designed to sample the macrobenthos of sand and gravel substrates of rivers and streams and the littoral zones of lakes.

METHODS

Construction

The grab is illustrated in Fig. 1. All parts, with the exception of the pneumatic cylinders, valves, bushes and screws, were made from mild steel and galvanized for protection against corrosion.

The sample chamber, Fig. 1.1, was constructed from 14 gauge, (1.9 mm) mild steel sheet and electrically welded along the joint. The height of the chamber is 15.24 cm, with outside dimensions of 20.32 x 20.32 cm. The lids, Fig. 1.2, were cut from 16 gauge sheet metal (1.6 mm thick), and were attached to the sample chamber with 8-32 steel screws. The jaws, Fig. 1.3, were constructed from 14 gauge (1.9 mm) mild steel sheet and reinforced along the cutting edges with 1-1/2" x 1/8" (38 x 3.2 mm) steel flat bar, electrically welded and sharpened on the sides and lower edges to ensure a better cutting action. The lugs, Fig. 1.4, for the lower ram pivots were made from 3/16", (4.76 mm) steel plate and were welded centrally on the upper edge of each jaw. The jaws are attached to the sample chamber with 3/8" (9.5 mm) diameter bolts bearing on phosphor bronze bushes.

The bridge frame and housing, Fig. 1.5, for the upper ram pivots was constructed from 1" x 1/4" (25.4 x 6.4 mm) and 3" x 1/4" (76.2 x 6.4 mm) steel flat bar, and is attached to the sample chamber with four 3/8" (9.5 mm) diameter stainless steel screws. A 1/2" (12.7 mm) diameter NPT (national pipe thread) coupling (Fig. 1.6) was welded on to the upper frame for attachment of the extension handle. The handle, (pole) is simply a series of one or two meter 3/4" (19.05 mm) diameter pipes coupled together to cover the depth in which the grab is employed.

The jaws are activated by two double acting pneumatic cylinders (Fig. 1.7) with a 31.75 mm bore, 12.5 mm shaft, giving a 126 mm stroke with a pressure rating of 2000 PSI (13,790 kPa). The air is supplied from a scuba tank equipped with air pressure gauges and regulator, via a 1/4" (6.4 mm) diam. high pressure air line. A "Whitey" two-way valve (Fig. 1.8) operates the opening and closure of the jaws in conjunction with two adjustable exhaust valves (Fig. 1.9) connected to the small bore air line leading to the ports at each end of the cylinders.

An oiler (Fig.1.10) was inserted in the bottom port of each cylinder for lubriction and to prevent rusting.

Operation

The pressure gauge on the scuba tank was set at 60 PSI (413.7 kPa). (This was found to be the best operating pressure over various substrates, but of course, may be increased for operating in denser substrates.) With the jaws in the open position, the exhaust valve leading to the top of the cylinders is closed and the bottom valve opened. The two-way directional control valve is now set to the closing position and the grab is ready for use. The grab is then lowered to the bottom and held firmly into the substrate by applying manual pressure on the extension pole. The jaws are closed by opening the valve on the scuba tank. When the grab has been lifted clear of the water, it is held over a fine mesh net, and the procedure for closing the jaws is reversed, i.e. the exhaust valve leading to the top of the cylinders is opened and the other closed. The two-way control valve is then set to the open position.

Comparison of efficiency of grabs

Six samples were taken with this grab and with a weighted Ponar grab (Powers and Robertson 1967) in each of: sand and gravel substrates in the Roseau River, Manitoba, and sand interlaced with twigs in Roddy Lake, N.W. Ontario. Although the pneumatic grab can be operated by one person, two people operated it during those trials. Samples were sorted under the low power of a dissecting microscope, to order or family and counts of the numbers of each macrobenthic taxon were used to determine the efficiency of the pneumatic grab relative to the Ponar. The numbers of macrobenthos collected were converted to number$\cdot m^{-2}$, this number was then log transformed $\ln(n+1)$ to homogenize the variances and give "truer" values of statistical significance (Bartlett 1947). The log transformed data were then compared using the t-test (Freund 1962, p. 268).

RESULTS AND DISCUSSIONS

For the most part the pneumatic grab collected more animals of each taxon then the Ponar (Fig. 3,4,5). The only exceptions were in the numbers of Trichoptera and chironomid pupae from the Roseau River sand substrate (Fig. 4). In this substrate relatively small numbers of animals and large variation between samples were

encountered, thus none of the differences found were statistically significant (Table 1).

In the other two sustrates the pneumatic grab collected significantly more of almost every taxon and of total macrobenthos (Table 1).

In addition to these trials, the pneumatic grab has been used very successfully for a sampling season on an exposed cobble shore in Dauphin Lake, Manitoba. Samples taken with this sampler collected many more Ephemera simulans than samples with other grabs and allowed the life history of this species to be delineated (B. Heise, Dept. Entomology, University of Manitoba, personal communication).

The most probable reasons for the success of the pneumatic grab have previously been discussed by Burton (1978). These are:

1. The pneumatic grab was based on the Birge-Ekman design (Birge 1922), i.e. it is a box or sampling chamber which penetrates the substrate, and a powerful jaw-bite to enclose the sample. In the Peterson style of sampler (including the Ponar) the area inside the jaws is the actual sampling chamber. In this latter type of sample the sampler leaves the substrate before complete closure of the jaws, thus some of the sample is lost.
2. The pneumatic grab is operated using a pole or handle, (but see below) thus there is control over the depth of penetration and the "veering" problem of line-operated grabs is eliminated.
3. Because the grab is operated pneumatically, it has the power to cut through twigs and branches, such as those encountered in the Roddy Lake sand. It will also move stones and pebbles out of the path of the jaws. In several instances, in these trials, the Ponar jaws were jammed open with twigs or stones. (Note that during these trials these samples were discarded.)
4. The pneumatic grab is light (9 kg) compared to the Ponar (55 kg). This enabled the operator to have more control over it.
5. It has the other advantages that Birge-Ekman style grabs have over the Peterson type of grabs. (Brinkhurst 1967; Flannagan 1970 etc.) e.g. reduction of frontal pressure or "bow" wave.

Murray and Charles (1975) described a pneumatic grab designed for work in deep water. Their grab involves using a long air line from a tank at the surface to the grab at the bottom. A deep water version of the grab described herein, which can be operated remotely is presently being developed, i.e. an air-tank and valve tripping mechanism will be attached to the grab, and closure of the jaws will be achieved using a messenger. This will eliminate the need for the long, unwieldy air line.

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Table 1. t-Values for differences between $\log_n$ (numbers$\cdot m^{-2}$ + 1) of macrobenthic taxa estimates from samples collected with the Ponar and Pneumatic grabs in various substrates. Where significant differences are indicated the Pneumatic grab had the higher numbers.

	Ephemeroptera	Trichoptera	Chironimidae Larvae	Chironimidae Pupae	Coleoptera	Pelycepoda	Plecoptera	Other Aquatic Macroinvertebrates	Totals
Roseau River sand	0.53	0.09	1.24	0.18	---	0.86	---	0.82	1.07
Roseau River gravel	7.42**	2.03	5.09**	---	3.73**	4.50**	1.91	5.39**	5.27**
Roddy Lake sand	2.33*	2.13	1.40	---	3.33**	---	---	2.33*	3.25**

* Difference significant at P<0.05.
** Difference significant at P<0.01.

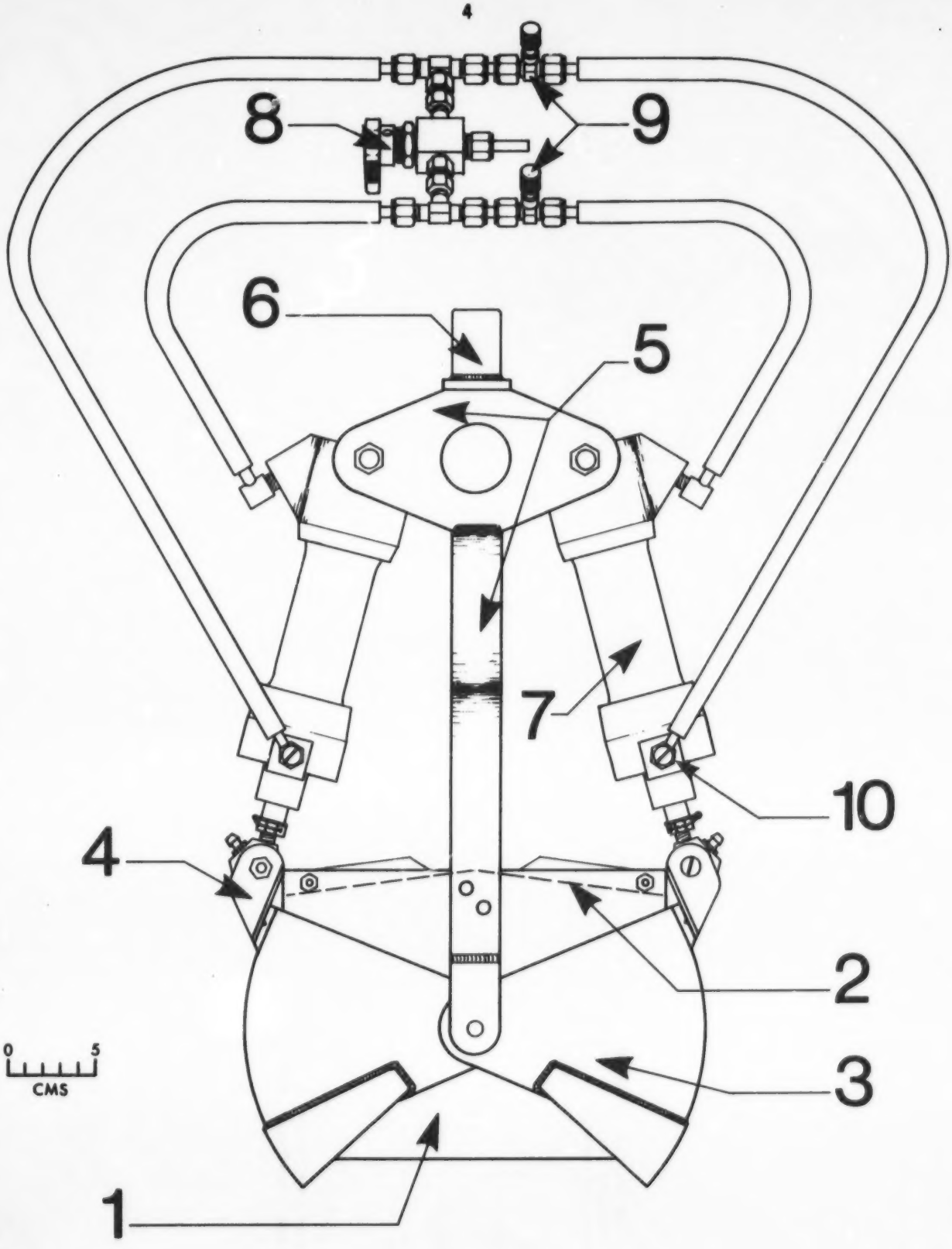

Fig. 1. Plan of the pneumatic grab (See text for explanation of numbers).

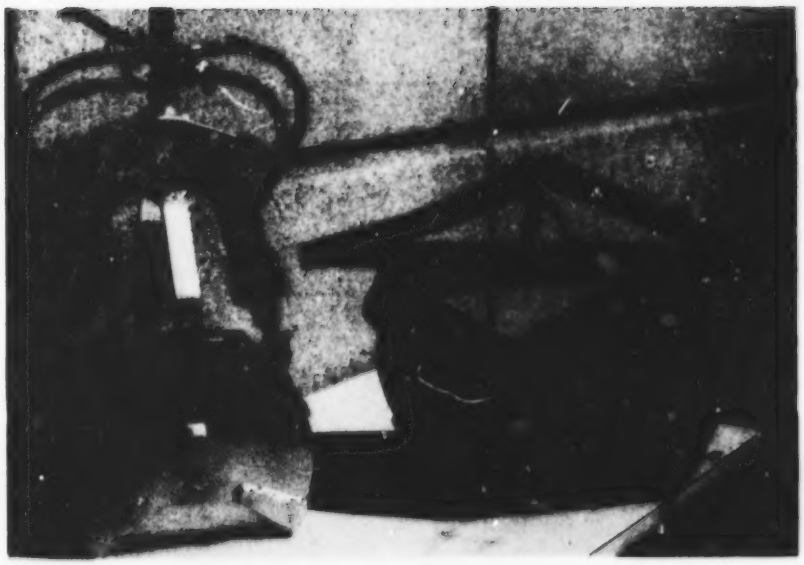

Fig. 2. Photograph of pneumatic grab and Ponar grab.

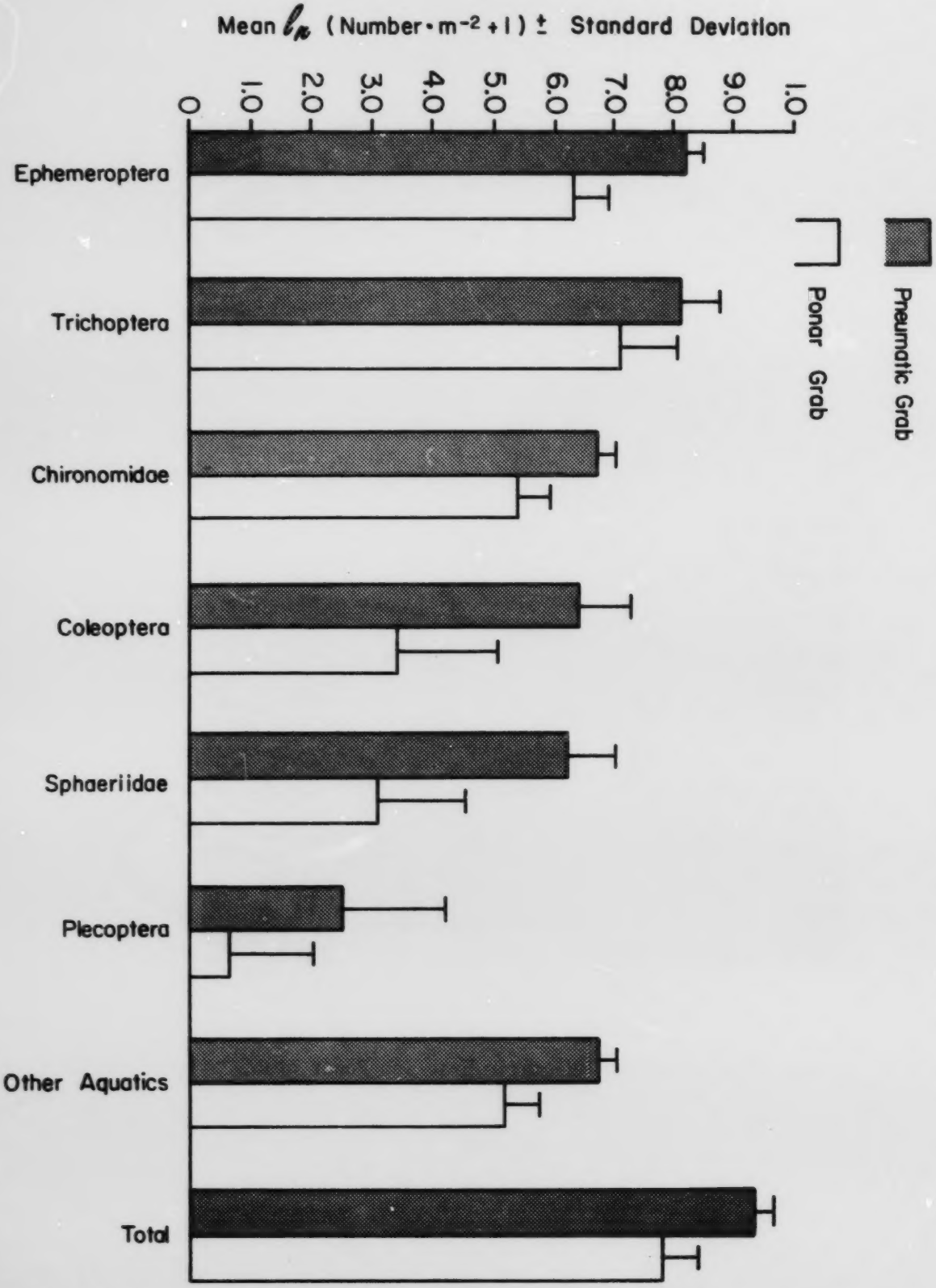

Fig. 3. Mean l_n (Number·m^{-2}+1) and standard deviations of macrobenthic animals estimated from samples collected in the gravel substrate of the Roseau River.

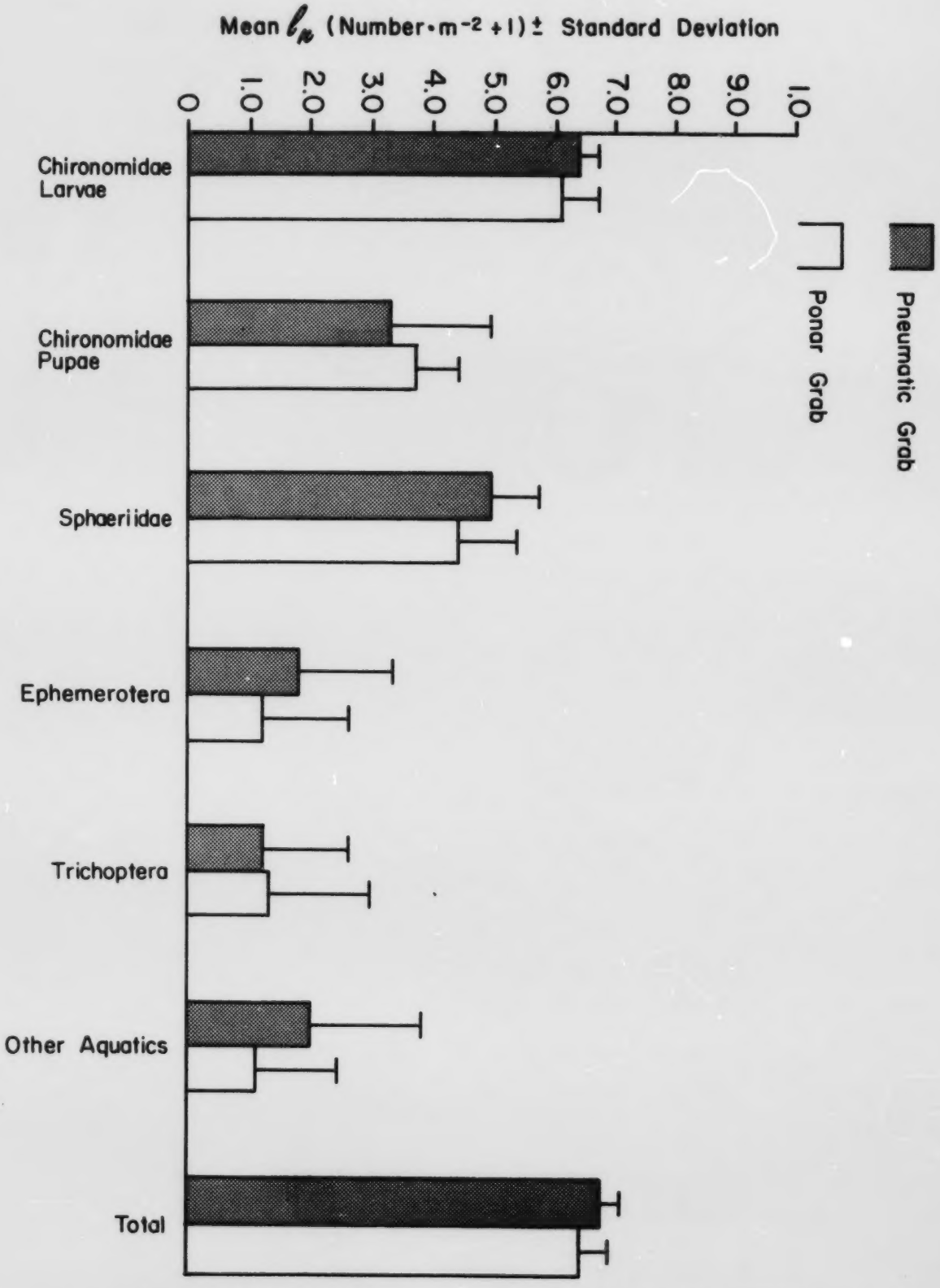

Fig. 4. Mean l_n (Number·m^{-2}+1) and standard deviations of macrobenthic animals estimated from samples collected in the sand substrate of the Roseau River.

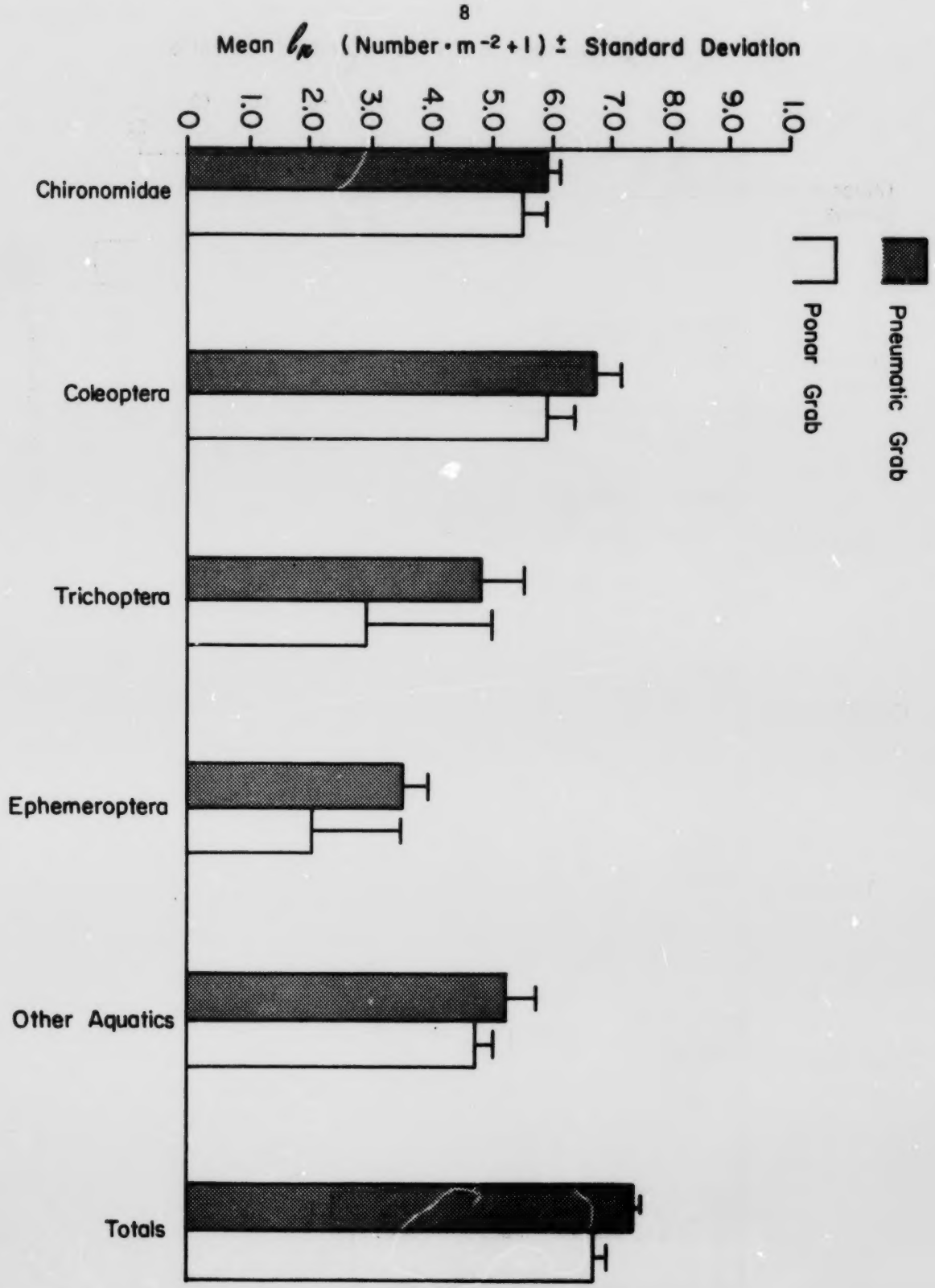

Fig. 5. Mean l_n (Number·m^{-2}+1) and standard deviations of macrobenthic animals estimated from samples collected in the "sand with twigs" substrate of Roddy Lake.